PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

March 26, 1874.—Joseph Dalton Hooker, C.B., President, in the Chair.

"On the Organization of the Fossil Plants of the Coal-measures. —Part VI. Ferns." By W. C. Williamson, F.R.S., Professor of Natural History in Owens College, Manchester.

The author called attention to the various methods of classifying the fern-stems and petioles of the Coal-measures adopted by Cotta, Corda, Brongniart, and others, and to the difficulties which attend those methods. Some of those difficulties had been already felt and partially removed by M. Brongniart. All the generic distinctions hitherto adopted were based upon variations in the form, number, and arrangement of the vascular bundles. These elements vary so much, not only in different species of the same genus, but in different parts of the same petiole, as to make them most untrustworthy guides to generic distinctions. The consequence has been an enormous multiplication of genera; but, notwithstanding their number, the author found that if he adopted the methods of his predecessors he would have to establish additional ones for the reception of his new forms. Under these circumstances he decides that it will be better to include the entire series of these petioles, provisionally, under the common generic term of *Rachiopteris*. This plan dispenses with a number of meaningless genera, and is rendered additionally desirable by the circumstance that all the petioles to which these numerous generic names have been applied belong to fronds which have already received other names, such as *Pecopteris*, *Sphenopteris*, &c.; only the structure of fronds found in the shales, and their respective petioles of which we have ascertained the structure, have not yet been correlated.

As a preparation for the present investigation, the author made an extensive series of researches amongst recent British and foreign fern-stems and petioles, with the object of ascertaining not only the modifications in their arrangements in different parts of the same plant, but especially of studying the modes in which secondary and tertiary vascular bundles were derived from the primary ones. This inquiry led him over the ground previously traversed by M. Trécul and, so far as British ferns were concerned, by Mr. Church.

The most common general forms exhibited by transverse sections of these bundles in recent petioles may be represented by the letters H, T, U, and X. As a general rule, the secondary bundles are given off from that part of the primary one which happens to be nearest to the secondary rachis to be supplied. Thus in some cases the upper arms of the X will merely be prolonged and their

ends detached; in other cases a loop projects from the *side* of one or both arms of the U, and becomes detached as a ring.

The first petiole, described under the name of *Rachiopteris aspera*, is one in which transverse sections of the central vascular bundle exhibit modifications of the H form at its base, separating into two contiguous bundles higher up, and ultimately reverting to the V form—the gutter-shaped bundle (*en gouttière*) of M. Trécul. This is the plant to which, on a previous occasion, the author proposed to assign the generic name of *Edraxylon* (Proc. Roy. Soc. vol. xx. p. 438). The vessels are chiefly reticulate, with some of the barred and spiral types. The bark consists of a delicate inner parenchyma, the cubical cells of which are arranged vertically. This is enclosed in a coarser middle parenchyma; and the whole is surrounded by an outer layer, composed of intermingled parenchyma and prosenchyma, the latter being disposed in vertical fibrous bands, having wedge-shaped transverse sections, and being modifications of the sclerenchyma of authors. The outer surface of the bark is covered with innumerable little, obtuse, projecting cellular appendages, which are obviously abortive hairs. These appendages are relatively larger in the smaller rachis than in the larger petioles. In very young petioles transverse bands of small consolidated cells traverse the bark at numerous points, reminding us of the similar conditions seen in the *Heterangium Grievii*, described in a previous memoir. In the larger petioles these cellular bands have disappeared, and left in their places large intercellular lacunæ. Numerous fragments of the terminal rachis of the above plant have been obtained with the leaflets attached. For a long time the author believed that he could identify these with the detached leaflets of a *Pecopteris* which are very abundant in the Oldham nodules; but later researches have led to the conclusion that the plant has been a *Sphenopteris*, closely allied to, if not identical with, the *S. Hoeninghausi* of Brongniart. The author proposes the provisional name of *Rachiopteris aspera* for the above plant.

The next petiole described is one to which Mr. Binney proposed ('Proceedings of the Literary and Philosophical Society of Manchester,' Jan. 9, 1872) to give the name of *Stauropteris Oldhamia*. This is one of the plants of which the vascular bundle, when seen in transverse section, exhibits the appearance of the letter X. The vessels composing this bundle are barred ones; they are sometimes grouped in four slightly coherent clusters, with some delicate, vertically elongated cells in or near their central point of conjunction. The same kind of cellular tissue surrounds the bundle, forming a thin layer, which passes rapidly into a very thick layer of coarse prosenchyma, and which has evidently been hard and woody, as in many of the recent Adiantums. Towards the upper part of the petiole the vascular bundle becomes distinctly consolidated into a single cluster of crucial form; it then passes into a somewhat trifid form, and ultimately into a small cylindrical one. This petiole has branched much more freely than

any of the others described. Two of the extremities of the crucial arms of the vascular bundle become first enlarged and then detached as two secondary bundles, which generally have an irregularly triangular transverse section, with long arms to the triangle. These triangular bundles are altogether different from the central axis of *Asterophyllites* described in a preceding memoir. The ultimate subdivisions of these secondary branches look more like the terminations of cylindrical rootlets than of petioles—which fact, combined with the circumstance that no traces of leaflets have been found associated with any of these ultimate twigs, renders the petiolar nature of this plant open to question, though the arguments in favour of its being a branching fern-petiole preponderate over those which militate against that conclusion. The author designates this plant *Rachiopteris Oldhamia*.

The next plant described is an exquisitely beautiful petiole from Burntisland, to two detached portions of which the author has already assigned the names of *Arpexylon duplex* and *A. simplex**, but which two forms he now proves to belong to the same plant. In the matured petiole the vascular bundle is always a double one. There is a central bundle, exhibiting a transverse section shaped like an hour-glass, one side of which is truncated and the other rounded, with a free, narrow, crescentic band at the more truncate of its enlarged extremities. At each of these extremities of the central bundle there is a longitudinal groove, which is shallow on the truncated side nearest to the crescentic bundle, but so surrounded by small vessels at the opposite convex side as often to become converted into a longitudinal canal. The hour-glass bundle always reappears in various specimens under the same aspect; but the crescentic one divides into two lateral halves, and the ends of each of these two subdivided parts curl under their more central portions. We thus obtain two of the crescentic structures previously designated *Arpexylon simplex*. These crescents are traced outwards through the bark to lateral secondary raches. The vessels thus detached from the truncated side of the central hour-glass bundle now reappear at its opposite and more convex side, whence, in turn, they again become detached; so that the truncate surface with its crescentic appendage, and the more oblate one with its almost closed canal, have alternately reversed their positions in the petiole as each secondary rachis was given off. Alternating distichous tertiary raches spring from these secondary ones.

Two plants which appear to be identical with those described by M. Renault, under the names of *Zygopteris Lacattii* and *Z. bibractiensis*, are next examined †. In these plants the section of the central bundle exhibits a form of the letter H. The vessels of the large central transverse bar are all reticulated ones: the greater part of those of the terminal vertical bars are of the same character; but the outermost vessels of those latter structures are

* Proceedings of the Royal Society, vol. xx. p. 438.
† Annales des Sciences Naturelles, 5e série, Bot. tome xii.

barred or quasi-scalariform. As in the case of *R. duplex*, already described, these outermost layers of barred vessels, accompanied by a few reticulated ones, become detached alternately from opposite sides of the H-shaped central bundle. Passing quickly through a thin delicate cellular inner bark, they enter the coarser parenchyma of a middle one, as two irregular clusters of vessels with one common investment prolonged from the innermost bark. On reaching the outer bark they become two distinct cylindrical bundles, each with its own delicate cortical investing layer; and thus invested, they emerge from the primary petiole to supply the secondary rachis.

The Oldham specimens of *Rachiopteris bibractiensis* agree with those described by M. Renault in having all their vessels of the barred type. The outer bark projects at numerous points in large conical abortive hairs, which almost assume a spinous aspect.

The author further figures and describes the section of a vascular axis, with a central cellular medulla surrounded by five contiguous crescentic masses of vascular tissue, whose concavities are directed outwards. This plant appears identical with the *Anarchopteris Decaisnii* of Renault.

May 21, 1874.—William Spottiswoode, M.A., Treasurer and Vice-President, followed by Dr. Sharpey, Vice-President, in the Chair.

"On the Structure and Development of *Peripatus capensis*." By H. N. Moseley, M.A., Naturalist to the 'Challenger' Expedition.

The author commences by expressing his obligations to Professor Thomson, who gave him assistance in some parts of his work, and every encouragement in the further prosecution of it.

Specimens of *Peripatus* were collected at the Cape of Good Hope during the stay of H.M.S. 'Challenger' at Simon's Bay, with a view to the investigation of the development of the animal. A specimen was dissected and at once seen to be provided with tracheæ, and to contain far developed young. This led to as careful an examination being made as time would permit, and hence the present paper. The most modern paper on *Peripatus* is that of Grube*. Grube, after examining the anatomy of the animal, came to the conclusion that it was hermaphrodite, and placed it among the "Bristle-Worms" in a separate order, Onychophora. Grube has been followed in most text-books, such as those of Claus and Schmarda; but uncertainty on the matter has been generally felt. De Quatrefages† follows Gervais in placing *Peripatus* in affinity with the Myriopods; and the result of the present investigation is to show that he is not far wrong.

The species made use of appears to be *Peripatus capensis*, described by Grube in the Zoological Series of the 'Novara' expe-

* Müller's Archiv, 1853. † Hist. des Annelés.

dition. The animal has invariably seventeen pairs of ambulatory members, a pair of oral papillæ, and two pairs of horny hooked jaws, shut in by tumid lips. The specimens found varied in length from 1·6 to 7 centims. (in the contracted condition). About thirty specimens were found, all of them but one at Wynberg, between Simon's Bay and Cape Town. The animals appear to be somewhat local and not very abundant; they live in damp places under trees, and especially frequent rotten willow-wood. They feed on rotten wood. They are nocturnal in their habits. They coil themselves up spirally like *Iulus* when injured. They have a remarkable power of extension of the body, and when walking stretch to nearly twice the length they have when at rest. They can move with considerable rapidity. They walk with the body entirely supported on their feet. Their gait is not in the least like that of worms, but more like that of caterpillars. When irritated they shoot out with great suddenness from the oral papillæ a peculiarly viscid tenacious fluid, which forms a meshwork of fine threads, with viscid globules on them at intervals, the whole resembling a spider's web with the dew upon it. The fluid is ejected at any injuring body, and is probably used in defence against enemies, such as insects, which would be held powerless for some time if enveloped in its meshes. The fluid is not irritant when placed on the tongue, but slightly bitter and astringent; it is as sticky as birdlime: flies, when they alight in it, are held fast at once. The fluid is structureless, but presents an appearance of fine fibrillation when dry. The animal is best obtained dead in an extended condition by drowning it in water, which operation takes four or five hours.

Only those points in anatomy are touched on which appear to have hitherto been wrongly or imperfectly described.

The intestinal tract is not straight, as described by Grube, but longer than the body, and usually presents one vertical fold; it presents numerous irregular sinuous lateral folds, but is not enlarged in every segment, as stated by Grube. Special regions, a muscular pharynx, short œsophagus, long stomach, and short rectum, are distinguished in the tract. The viscid fluid ejected from the oral papillæ is secreted by a pair of ramified tubular glands lying at the sides of the stomach and stretching nearly the whole length of the body. These glands are those described by Grube as testes; they show a common glandular structure, but no trace of testicular matter. A pair of enlargements on the ducts of the glands, provided with spirally arranged muscles, serve as ejaculatory reservoirs. The lateral elongate bodies lying outside the nerve-cords, considered by Grube to be vessels, show a fatty structure, vary much in extent, and are probably to be regarded as representing the fatty bodies of Tracheata.

No structure like that of the heart of Myriopods was found in the dorsal vessel.

The tracheal system consists of long fine tracheal tubes, which very rarely branch: these arise, in densely packed bunches, from

short common tubes, which open all over the body by small outlets in the epidermis ; these outlets have no regular structure, and are difficult to see. The whole of the tracheal system, very conspicuous in the fresh condition, becomes almost invisible when the animal examined has been a short time in spirit and the air has been thus removed from the tracheæ. Hence the failure of Grube to see them. The tracheæ are distributed in meshworks to all the viscera. The spiral filament is very imperfectly developed. A row of larger oval spiracles exists along the middle line of the under surface, the spiracles being placed opposite the interspaces of the feet, but not quite regularly. Other large spiracles exist on the inner sides of the bases of the feet. A large supply of tracheæ goes to the rectum and muscular pharynx. In many points the structure of the tracheal system resembles that in *Iulus*.

Peripatus is not hermaphrodite. Out of thirty specimens about ten were males. No outward distinction of the sexes could be discovered. The female organs consist of a small oblong ovary situate behind the stomach, about one sixth of the length from the end of the body ; from this lead a pair of oviducts, which, at their terminations, become enlarged and perform a uterine function, appearing, when filled with embryos, like a string of sausages. In nearly all cases, even when the embryos were far advanced, two large masses of spermatozoa were found in the ovary, and others attached to the ovisacs externally. A long loop, formed by the oviducts on each side, being quite loose in the body, becomes often thrown into a knot through the constant protraction and retraction of the body-wall. The knot is known to sailors as an overhand knot on a bight. The knot sometimes becomes drawn very tight, and then prevents the passage of the embryos above it. A case was met with in which this had occurred. The upper parts of the oviducts were mortified off at the knot, and remained attached only to the ovary. The ducts were dilated into large single sacs, the usual constrictions between the embryos having disappeared, and were full of decomposed embryos and fatty tissue. The knot was met with in many specimens—in some cases on both sides of the body, in others on only one. The oviducts unite in a short common tube to open at the simple vulva. The male organs consist of a pair of large ovoid testes, surmounted by short tubular prostates. The vasa deferentia are long and tortuous, forming, near the testes, spiral coils in which the ducts are enlarged, and which may be called vesiculæ seminales. A muscular ejaculatory tube, or penis, lies on one side of the body—sometimes on one, sometimes on the other. One vas deferens passes across, at the end of the body, under both nerve-cords to join the penis ; the other takes a more direct course, not passing under the cords at all. In the original condition both ducts probably passed one under each nerve-cord, to join the centrally placed common terminal tube, homologous with that of the female organs.

The spermatozoa are filamentary, as in insects and in *Scolopendra*, but not in *Iulus*. Their development is described. They

are very long; and their tails have a spiral movement as well as an undulatory one. They twist into all sorts of loops.

The muscular tissue of *Peripatus* is unstriated.

The development of *Peripatus* was only partially followed. As a rule, all the embryos found in one mother are of the same age. In some cases slight differences were found, which were very valuable for determining the development of the parts of the mouth. The embryos lie coiled up in simple hyaline envelopes, enclosing an ovoid cavity, within the enlargements of the uterine tubes. In the earliest stage observed the embryo had large round cephalic lobes and was without members, but showed distinct segmentation about its middle; it was coiled up spirally, the head being free, the tail in the axis of the coil. Later on the embryo becomes bent round in an oval, with the tip of the tail resting between the antennæ.

The front members are formed first: they arise as undulations of the lateral wall of the body, which become pushed further and further outwards, and are at first hollow, formed of two layers of cells, the inner of which is reflected over the intestine. The members form one after another, from the head downwards. A line of segmentation is formed across the body before the pair of members swells out, but disappears as they develop. The wall of the digestive tract is, in the early condition, drawn out laterally at each interspace between the pairs of members, to become attached there to the body-wall. The cephalic lobes early show traces of a separation into two segments, anterior and posterior; from them, anteriorly, bud out the antennæ, which gradually become more and more jointed. The mouth forms before the anus.

The full number of body-members is very early attained. The second pair are the largest at first, but subsequently become the small oral papillæ. The first pair turn inwards towards the primitive mouth-opening, and, developing their claws greatly, form the pair of horny jaws; these are covered by processes which grow down from the lower part of the head, and which eventually unite with the tissues at the bases of the oral tentacles and form the tumid lips, which, eventually closing in, hide all the parts of the mouth in the adult. The head-processes are probably homologous with the mandibles of higher Tracheata, the horny jaws with the maxillæ and the oral papillæ with the foot-jaws of *Scolopendra*; a regular labrum is formed by a downward growth from the front of the head, but is eventually shut in by the tumid lips.

It is uncertain whether a corresponding structure beneath the mouth represents the second underlip of *Scolopendra* or a true labium. The foot-claws are developed in invaginations of the tips of the ambulacral members. The young members develop five joints each, the typical number in insects, and one which seems to be retained in the adult.

In the present state of our knowledge concerning the structure of *Peripatus*, the most remarkable fact in its structure is the wide

divarication of the ventral nerve-cords. The fact was considered remarkable and dwelt upon in all accounts of *Peripatus* before the existence of tracheæ in the animal was known, and when it was thought to be hermaphrodite; but it is doubly remarkable now. The fact shuts off at once all idea of *Peripatus* being a degenerate Myriopod, the evidence against which possibility is overwhelming. The bilateral symmetry and duplicity of the organs of the body, the absence of striation in the muscles, of periodical moults of the larval skin in development, and of any trace of a primitive three-legged condition, taken in conjunction with the divarication of the nerve-cords, are conclusive. The parts of the mouth are not to be regarded as degraded to any great degree; and homologies for some of them, at least, may perhaps be found amongst the higher Annelids. The structure of the skin is not at all unlike that in some worms, especially in its chitinous epidermic layer, which occasionally strips off in large pieces as a thin transparent pellicle. The many points of resemblance of *Peripatus* to Annelids need not be dwelt upon; they led to its former placing in classification; but it is difficult to understand how the very unannelid-like structure of the foot-claws did not lead others beside De Quatrefages to draw a line between *Peripatus* and the Annelids. In being unisexual, *Peripatus* is like the higher Annelids, as well as the whole of the higher Tracheata. To Insects *Peripatus* shows affinities in the form of the spermatozoa, and the elaboration, structure, and bilateral symmetry of the generative organs, though there is a very slight tendency towards the unilaterality of Myriopods in the male organs.

To Insects, again, it is allied by the five-jointing of the feet and oral papillæ and the form and number of its claws. It should be remembered that spiders' feet are two-clawed, as are those of some Tardigrades, and that some of these latter forms have two-clawed feet in the early condition even when they possess more claws in the adult state. In Newport's well-known figure of the young *Iulus* with three pairs of limbs, the tips of these latter are drawn with *two* hair-like claws; these are not mentioned in the text. To the ordinary lepidopterous larva the resemblances of *Peripatus* are striking—as, for example, the gait, the glands (so like in their function and position to silk-glands), the form of the intestine, and the less perfect concentration of the nervous organs, as in larval insects. To Myriopods *Peripatus* is allied by the great variety in number of segments in the various species, in its habits, and in these especially to *Iulus*. The parts of the mouth perhaps show a form out of which those of *Scolopendra* were derived by modification; but the resemblance may be superficial. Our knowledge is not yet sufficient to determine such points. The usual difficulties occur in the matter. Segments may have dropped out or fused; and their original condition may not be represented at all in the process of development. In structure *Peripatus* is more like *Scolopendra* than *Iulus*, viz. in the many joints to the antennæ (in Chilognaths never more than fourteen), in the form of the sperma-

tozoa, and in being viviparous, as are some *Scolopendræ* ; further, in the position of the orifices of the generative glands and in the less perfect concentration mesially of the nerve-cords in *Scolopendra*.

Peripatus thus shows affinities, in some points, to all the main branches of the family tree of Tracheata ; but a gulf is fixed between it and them by the divarication of the nerve-cords. Tending in the same direction are such facts as the non-striation of the muscles, the great power of extension of the body, the arrangement of the digestive tract in the early stage, the persistence of metamorphosis, and the nature of the parts of the mouth—the full history of the manner of origin of these being reserved.

There are many speculations as to the mode of origin of the tracheæ themselves in the Tracheata. Professer Häckel (' Biologische Studien,' p. 491) follows Gegenbaur, whose opinion is expressed in his ' Grundzüge der vergleichenden Anatomie,' p. 441. Gegenbaur concludes that tracheæ were developed from originally closed tracheal systems, through the intervention of the tracheal gills of primæval aquatic insects now represented as larvæ. If *Peripatus* be as ancient in origin as is here supposed, the condition of the tracheal system in it throws a very different light on the matter. *Peripatus* is the only Tracheate with tracheal stems opening diffusely all over the body. The Protracheata probably had their tracheæ thus diffused, and the separate small systems afterwards became concentrated along especial lines and formed into wide main branching trunks. In some forms the spiracular openings concentrated towards a more ventral line (*Julus*) ; in others they took a more lateral position (Lepidopterous larvæ, &c.). A concentration along two lines of the body, ventral and lateral, has already commenced in *Peripatus*. The original Protracheate being supposed to have had numerous small tracheæ diffused all over its body, the question as to their mode of origin again presents itself. The peculiar form of the tracheal bundles in *Peripatus*, which consist of a number of fine tubes opening into the extremity of a single short common duct leading to the exterior of the body, seems to give a clue. The tracheæ are, very probably, modified cutaneous glands, the homologues of those so abundant all over the body in such forms as *Bipalium* or *Hirudo*. The pumping extension and contraction of the body may well have drawn a very little air, to begin with, into the mouths of the ducts ; and this having been found beneficial by the ancestor of the Protracheate, further development is easy to imagine. The exact mode of development of the tracheæ in the present form must be carefully studied ; there was no trace of these organs in the most perfect state of *Peripatus* which I obtained.

Professor Gegenbaur's opinion on the position of *Peripatus* (' Grundzüge der vergleichenden Anatomie,' p. 199) is, that its place among the worms is not certain, but that, at any rate, it connects ringed worms with Arthropods and flat worms. The general result of the present inquiry is to bear out Professor

Gegenbaur's opinion; but it points to the connexion of the ringed and flat worms, by means of this intermediate step, with three classes only of the Arthropods—the Myriopods, Spiders, and Insects, *i. e.* the Tracheata. From the primitive condition of the tracheæ in *Iulus*, and the many relations between *Peripatus* and *Scolopendra*, it would seem that the Myriopods may be most nearly allied to *Peripatus*, and form a distinct branch arising from it and not passing through Insects. The early three-legged stage may turn out as of not so much significance as supposed. If these speculations be correct, the Crustacea have a different origin from the Tracheata. *Peripatus* itself may well be placed amongst Professor Häckel's Protracheata; Grube's term Onychophora becomes no more significant than De Blainville's Malacopoda. Some notions of the actual history of the origin of *Peripatus* itself may be gathered from its development.

In conclusion I would beg indulgence for the many defects in this paper, due to the hurry with which it was written (all available time, almost up to the last moment of our sailing for the Antarctic regions, having been consumed in actual examination of the structure of *Peripatus*), and due, further, to the impossibility of referring to original papers in any scientific library. At all events it is hoped that *Peripatus* has been shown to be of very great zoological interest, as lying near one of the main stems of the great zoological family tree, and that further examination of the most minute character into the structure of this animal will be well repaid.

H.M.S. 'Challenger,' Simon's Bay, Cape of Good Hope,
December 17, 1873.

June 18, 1874.—Joseph Dalton Hooker, C.B., President, in the Chair.

"On Dredgings and Deep-sea Soundings in the South Atlantic, in a Letter to Admiral Richards, C.B., F.R.S." By Prof. Wyville Thomson, LL.D., F.R.S., Director of the Civilian Staff on board H.M.S. 'Challenger.'

Melbourne, March 17, 1874.

Dear Admiral Richards,—I have the pleasure of informing you that, during our voyage from the Cape of Good Hope to Australia, all the necessary observations in matters bearing upon my department have been made most successfully at nineteen principal stations, suitably distributed over the track, and including Marion Island, the neighbourhood of the Crozets, Kerguelen Island, and the Heard group.

After leaving the Cape several dredgings were taken a little to the southward, at depths from 100 to 150 fathoms. Animal life was very abundant; and the result was remarkable in this respect, that the general character of the fauna was very similar to that of the North Atlantic, many of the *species* even being identical with those on the coasts of Great Britain and Norway. The first day's

dredging was in 1900 fathoms, 125 miles to the south-westward of Cape Agulhas; it was not very successful.

Marion Island was visited for a few hours, and a considerable collection of plants, including nine flowering species, was made by Mr. Moseley. These, along with collections from Kerguelen Island and from Yong Island, of the Heard group, are sent home with Mr. Moseley's notes, for Dr. Hooker's information.

A shallow-water dredging near Marion Island gave a large number of species, again representing many of the northern types, but with a mixture of southern forms, such as many of the characteristic southern Bryozoa and the curious genus *Serolis* among Crustaceans. Off Prince Edward's Island, the dredge brought up many large and striking specimens of one or two species of Alcyonarian zoophytes, allied to *Mopsea* and *Isis*.

The trawl was put down in 1375 fathoms on the 29th December, and in 1600 fathoms on the 30th, between Prince Edward's Island and the Crozets. The number of species taken in these two hauls was very large; many of them belonged to especially interesting genera; and many were new to science. I may mention that there occurred, with others, the well-known genera *Euplectella*, *Hyalonema*, *Umbellularia*, and *Flabellum*, two entirely new genera of stalked Crinoids belonging to the Apiocrinidæ, *Pourtalesia*, several Spatangoids new to science (allied to the extinct genus *Ananchytes*), *Salenia*, several remarkable Crustaceans, and a few fish.

We were unfortunately unable to land on Possession Island on account of the weather; but we dredged in 210 fathoms and 550 fathoms, about 18 miles to the S.W. of the island, with a satisfactory result. We reached Kerguelen Island on the 7th of January, and remained there until the 1st of February. During that time Dr. v. Willemöes-Suhm was chiefly occupied in working out the land-fauna, Mr. Moseley collected the plants, Mr. Buchanan made observations on the geology of those parts of the island which we visited, and Mr. Murray and I carried on the shallow-water dredging in the steam-pinnace. Many observations were made, and large collections were stored in the different departments. We detected at Kerguelen Island some peculiarities in the reproduction of several groups of marine invertebrates, and particularly in the Echinodermata, which I have briefly described in a separate paper.

Two days before leaving Kerguelen Island, we trawled off the entrance of Christmas Harbour; and the trawl-net came up, on one occasion, nearly filled with large cup-sponges belonging to the genus *Rossella* of Carter, and probably the species dredged by Sir James Clark Ross near the ice-barrier, *Rossella antarctica*.

On the 2nd of February we dredged in 150 fathoms, 140 miles south of Kerguelen, and on the 7th of February off Yong Island, in both cases with success.

We reached Corinthian Bay, in Yong Island, on the evening of the 6th, and had made all arrangements for examining it, as far as possible, on the following day; but, to our great disappointment, a sudden change of weather obliged us to put to sea. Fortunately

Mr. Moseley and Mr. Buchanan accompanied Captain Nares on shore for an hour or two on the evening of our arrival, and took the opportunity of collecting the plants and minerals within their reach. A cast of the trawl taken in lat. 60° 52′ S., long. 80° 20′ E., at 1260 fathoms, was not very productive, only a few of the ordinary deep-sea forms having been procured.

Our most southerly station was on the 14th of February, lat. 65° 42′ S., long. 79° 49′ E. The trawl brought up, from a depth of 1675 fathoms, a considerable number of animals, including Sponges, Alcyonarians, Echinids, Bryozoa, and Crustacea, all much of the usual deep-sea character, although some of the species had not been previously observed. On February 26th, in 1975 fathoms, *Umbellulariæ*, *Holothuriæ*, and many examples of several species of the *Ananchytidæ* were procured; and we found very much the same group of forms at 1900 fathoms on the 3rd of March. On the 7th of March, in 1800 fathoms, there were many animal forms, particularly some remarkable starfishes, of a large size, of the genus *Hymenaster*; and on the 13th of March, at a depth of 2600 fathoms, with a bottom-temperature of 0°·2 C., *Holothuriæ* were abundant, there were several starfishes and *Actiniæ*, and a very elegant little Brachiopod occurred attached to peculiar concretions of manganese which came up in numbers in the trawl.

In nine successful dredgings, at depths beyond 1000 fathoms, between the Cape and Australia:—

Sponges were met with on	6	occasions.
Anthozoa Octactinia	7	,,
—— Polyactinia	6	,,
Crinoidea	4	,,
Asteroidea	8	,,
Ophiuridea	9	,,
Echinidea		
Holothuridea	8	,,
Bryozoa	6	,,
Tunicata	5	,,
Sipunculacea	3	,,
Nematodes	1	,,
Annelida	8	,,
(*Myzostomum*)	2	,,
Balanoglossus	1	,,
Cirripedia	4	,,
Ostracoda	1	,,
Isopoda	7	,,
Amphipoda	3	,,
Schizopoda	5	,,
Decapoda Macrura	6	,,
—— Brachyura	2	,,
Pycnogonida	2	,,
Lamellibranchiata	5	,,
Brachiopoda	2	,,

Gasteropoda	4 occasions.
Cephalopoda	3 „
Teleostei	6 „

It is of course impossible to determine the species with the books of reference at our command ; but many of them are new to science, and some are of great interest from their relation to groups supposed to be extinct. This is particularly the case with the Echinodermata, which are here, as in the deep water in the north, a very prominent group.

During the present cruise special attention has been paid to the nature of the bottom, and to any facts which might throw light upon the source of its materials.

This department has been chiefly in the hands of Mr. Murray ; and I have pleasure in referring to the constant industry and care which he has devoted to the preparation, examination, and storing of samples. I extract from Mr. Murray's notes :—

"In the soundings about the Agulhas bank, in 100 to 150 fathoms, the bottom was of a greenish colour, and contained many crystalline particles (some dark-coloured and some clear) of Foraminifera, species of *Orbulina*, *Globigerina*, and *Pulvinulina*, a pretty species of *Uvigerina*, *Planorbulina*, *Miliolina*, *Bulimina*, and *Nummulina*. There were very few Diatoms.

"In the deep soundings and dredgings before reaching the Crozets, in 1900, 1570, and 1375 fathoms, the bottom was composed entirely of *Orbulina*, *Globigerina*, and *Pulvinulina*, the same species which we get on the surface, but all of a white colour and dead. Of Foraminifera which we have not got on the surface I noticed one *Rotalia* and one *Polystomella*, both dead. Some Coccoliths and Rhabdoliths were also found in the samples from these soundings. On the whole, these bottoms were, I think, the purest carbonate of lime we have ever obtained. When the soundings were placed in a bottle and shaken up with water, the whole looked like a quantity of sago. The *Pulvinulinæ* were smaller than in the dredgings in the Atlantic. We had no soundings between the Crozets and Kerguelen.

"The specimens of the bottom about Kerguelen were all from depths from 120 to 20 fathoms, and consisted usually of dark mud, with an offensive sulphurous smell. Those obtained furthest from land were made up almost entirely of matted sponge-spicules.

In these soundings one species of *Rotalina* and one other Foraminifer occurred.

"At 150 fathoms, between Kerguelen and Heard Island, the bottom was composed of basaltic pebbles. The bottom at Heard Island was much the same as at Kerguelen.

"The sample obtained from a depth of 1260 fathoms, south of Heard Island, was quite different from any thing we had previously obtained. It was one mass of Diatoms, of many species, and, mixed with these, a few small *Globigerinæ* and Radiolarians and a very few crystalline particles.

"The soundings and dredgings while we were among the ice in 1675, 1800, 1300, and 1975 fathoms, gave another totally distinct deposit of yellowish clay, with pebbles and small stones, and a considerable admixture of Diatoms, Radiolarians, and *Globigerinæ*. The clay and pebbles were evidently a sediment from the melting icebergs; and the Diatoms, Radiolarians, and Foraminifera were from the surface-waters.

"The bottom from 1950 fathoms, on our way to Australia from the Antarctic, was again exactly similar to that obtained in the 1260-fathoms sounding south of Heard Island. The bottom at 1800 fathoms, a little further to the north (lat. 50° 1′ S., long. 123° 4′ E.), was again pure '*Globigerina*-ooze,' composed of *Orbulinæ*, *Globigerinæ*, and *Pulvinulinæ*.

"The bottom at 2150 fathoms (lat. 47° 25′ S., long. 130° 32′ E.) was similar to the last, with a reddish tinge; and that at 2600 fathoms (lat. 42° 42′ S., long 134° 10′ E.) was reddish clay, the same which we got at like depths in the Atlantic, and contained manganese nodules and much-decomposed Foraminifera."

Mr. Murray has been induced, by the observations which have been made in the Atlantic, to combine the use of the towing-net, at various depths from the surface to 150 fathoms, with the examination of the samples from the soundings. And this double work has led him to a conclusion in which I am now forced entirely to concur, although it is certainly contrary to my former opinion—that the bulk of the material of the bottom in deep water is, in all cases, derived from the surface.

Mr. Murray has demonstrated the presence of *Globigerinæ*, *Pulvinulinæ*, and *Orbulinæ* throughout all the upper layers of the sea over the whole of the area where the bottom consists of "*Globigerina*-ooze" or of the red clay produced by the decomposition of the shells of Foraminifera; and their appearance when living on the surface is so totally different from that of the shells at the bottom, that it is impossible to doubt that the latter, even although they frequently contain organic matter, are all dead. I mean this to refer only to the genera mentioned above, which practically form the ooze. Many other Foraminifera undoubtedly live, in comparatively small numbers, along with animals of higher groups, on the bottom.

In the extreme south the conditions were so severe as greatly to interfere with all work. We had no arrangement for heating the work-rooms; and at a temperature which averaged for some days 25° F., the instruments became so cold that it was unpleasant to handle them, and the vapour of the breath condensed and froze at once upon glass and brass work. Dredging at the considerable depths which we found near the Antarctic Circle became a severe and somewhat critical operation, the gear being stiffened and otherwise affected by the cold; and we could not repeat it often.

The evening of the 23rd of February was remarkably fine and calm; and it was arranged to dredge on the following morning. The weather changed somewhat during the night, and the wind

rose. Captain Nares was most anxious, however, to carry out our object, and the dredge was put over at 5 A.M. We were surrounded by icebergs; the wind continued to rise, and a thick snow-storm came on from the south-east. After a time of some anxiety the dredge was got in all right; but, to our great disappointment, it was empty: probably the drift of the ship and the motion had prevented its reaching the bottom. In the mean time the wind had risen to a whole gale (force=10 in the squalls), the thermometer fell to 21°·5 F., the snow drove in a dry blinding cloud of exquisite star-like crystals, which burned the skin as if they had been red-hot; and we were not sorry to be able to retire from the dredging-bridge.

Careful observations on temperature are already in your hands, reported by Captain Nares. The specific gravity of the water has been taken daily by Mr. Buchanan; and, during the trip, Mr. Buchanan has determined the amount of carbonic acid in 24 different samples—15 from the surface, 7 from the bottom, and 2 from intermediate depths. The smallest amount of carbonic acid was found in surface-water on the 27th January, near Kerguelen; it amounted to 0·0373 gramme per litre. The largest amount, 0·0829 gramme per litre, was found in bottom-water on the 14th February, when close to the Artarctic ice. About the same latitude the amount of carbonic acid in surface-water rose to the unusual amount of 0·0656 gramme per litre; in all other latitudes it ranged between 0·044 and 0·054 gramme per litre. From the greater number of these samples the oxygen and nitrogen were extracted, and sealed up in tubes.

The considerations connected with the distribution of temperature and specific gravity in these southern waters are so very complicated, that I prefer postponing any general *résumé* of the results until there has been time for full consideration.

While we were among the ice all possible observations were made on the structure and composition of icebergs. We only regretted greatly that we had no opportunity of watching their birth, or of observing the continuous ice-barrier from which most of them have the appearance of having been detached. The berg- and floe-ice was examined with the microscope, and found to contain the usual Diatoms. Careful drawings of the different forms of icebergs, of the positions which they assume in melting, and of their intimate structure were made by Mr. Wild; and instantaneous photographs of several were taken from the ship.

Upwards of 15,000 observations in meteorology have been recorded during the trip to the south. Most of these have already been tabulated and reduced to curves, and otherwise arranged for reference in considering the questions of climate on which they bear.

Many specimens in natural history have been stored in about seventy packing-cases and casks, containing, besides dried specimens, upwards of 500 store-bottles and jars of specimens in spirit.

I need only further add that, so far as I am able to judge, the

expedition is fulfilling the object for which it was sent out. The naval and the civilian staff seem actuated by one wish to do the utmost in their power, and certainly a large amount of material is being accumulated.

The experiences of the last three months have of course been somewhat trying to those of us who were not accustomed to a sea-life; but the health of the whole party has been excellent. There has been so much to do that there has been little time for weariness; and the arrangements continue to work in a pleasant and satisfactory way.

(Signed) Charles Wyville Thomson.

MISCELLANEOUS.

A new Order of Hydrozoa. By George J. Allman, F.R.S. &c.

On the southern shores of France, at a slight depth below the surface of the sea, there may be found attached to stones small patches of one of the horny sponges which will probably arrest the attention of the zoologist by what will appear to him as an unusually obvious and well-defined condition of their efferent orifices or oscula.

If one of these patches be transferred to a phial of sea-water, the observer will soon be astonished by seeing that from every one of the apparent oscula a beautiful plume of hydroid tentacles will have become developed, and he will naturally believe that the form has at last been found which will remove all doubt as to the zoological position of the sponges, and decide in favour of the hydroid affinities recently assigned to them *.

A more careful examination, however, will show that the orifices on the surface have been incorrectly regarded as oscula, and that the tentacles form no part of the sponge, but proceed from an entirely different organism which is imbedded in its substance.

It will be further seen that the organism with which the sponge is thus associated is contained in a congeries of chitinous tubes which permeate the sponge-tissue, and open on its surface in the manner of genuine oscula; and it will be still further apparent that this organism, while undoubtedly a hydrozoon, and even presenting quite the aspect of a hydroid trophosome, is no hydroid at all, and cannot indeed be referred to any of the hitherto recognized orders of the Hydrozoa, but must take its place in an entirely new and as yet undefined order of this class.

The chitinous tubes and their contents are united by a common tubular plexus which lies towards the base of the sponge, and they thus constitute a composite colony of zooids. The tubes, towards their free extremities, where they open on the surface of the sponge,

* See Haeckel's "Kalkschwämme."